

A SURVEY OF BEAVER ECOLOGY IN GRAND PORTAGE NATIONAL
MONUMENT, MINNESOTA

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INTRODUCTION

A study of beavers (Castor canadensis) was conducted in Grand Portage National Monument from 23 August thru 11 September 1987. The aims of the study were to begin examining basic population characteristics and habitat conditions of beavers living on the Monument and adjacent Indian lands.

These basic data on beavers are important for several reasons. First, resource managers at Grand Portage need data on the beaver population so that workable, feasible management programs can be instituted. Second, baseline data provides prospective for future monitoring of beavers. This is not only important in the scientific sense, but allows managers to evaluate their past decisions, a very important and often neglected part of wildlife management. Third, this relatively small project will be integrated into a comprehensive comparison of beavers in Voyageurs National Park, Isle Royale National Park, and Apostle Islands National Lakeshore. The other

projects are ongoing, but some available data is presented here. When all of these studies are complete, it will provide a comprehensive look at beavers in the Lake State areas managed by the National Park Service.

Specific aims were to examine basic population characteristics and habitat conditions of beavers on the Monument and adjacent Indian lands. Research objectives were as follows:

- 1) To determine beaver density and distribution on Monument lands
- 2) To determine colony size and composition
- 3) To obtain physical measurements of beavers
- 4) To assess relative habitat quality
 - a. vegetation
 - b. water
- 5) To examine ecosystem importance of beavers
- 6) To estimate dispersal and movements

Field work took place from two different locations:

1) Grand Portage trail and nearby Indian reservation colonies and 2) Pigeon river. Trapping from the Grand Portage area was from vehicle and foot, and from canoe and foot on the Pigeon river. Lodging was supplied by the National Park Service, and the Indian reservation while trapping on Pigeon river.

METHODS

TRAPPING AND BEAVER DENSITY

All beavers were captured and handled in Hancock live traps (Hancock Traps Co. Rt. 1 Box38-2 Buffalo Gap, S.D. 57722) baited with aspen, apple, or both. After several nights using these baited sets, scent, or disguised sets without bait were used. Animals were handled and measured in burlap sacks so sedating them was not necessary. Measurements taken from each beaver included: weight, total length, zygomatic breadth, tail length and width, hind foot length, and sex. Each beaver was tagged with inconspicuous metal ear markers for future identification. Number of animals per colony was estimated from live captures and evening observation periods at most of the lodges.

Beaver lodge density for the Monument was estimated from 1983 infrared aerial photographs of 1:12000 scale, and for the whole reservation with a black and white composite aerial photograph. Ponds with water and a dam were marked as active (although there is no way of knowing if beavers are present), drained ponds were not considered as active. Lakes were not recorded, for the extent of beaver activity could not be discerned from the photos. Past beaver use and distribution in relation to drainages was also noted.

VEGETATION SURVEYS

Two methods were used to quantify food conditions: 1) beaver cutting activity and 2) tree sampling by line transects. First, the entire area around the beaver pond was hiked in order to delineate areas of cutting activity, where species, diameter breast height (dbh), and distance from water were recorded for all freshly cut or downed trees. Within these areas, systematic sampling (point center quarter method) was used to determine preferred tree (aspen- Populus tremuloides) densities. Distances from lodge to feeding areas were also measured.

DAILY NOTES

In addition to systematic analyses of beavers, an attempt was made to record other wildlife species associated with beaver created habitat. Detailed notes were kept of all birds and mammals sighted in the course of the field work. Supplemental to these observations were citations and comparisons from other more detailed studies of beavers and their ecosystem importance.

RESULTS

Beavers were trapped for 18 nights with 8 traps for a total of 106 trap nights. Twenty-three animals in 7 lodges were handled for a 22% success rate or 4.6 trap nights per beaver capture. If recaptured animals (animals caught twice) are discarded then the calculated success rate was 29% or 3.4 trap nights per beaver capture. Four lodges were trapped on Grand Portage National Monument lands, and three lodges were trapped on Indian reservation land.

POPULATION DYNAMICS

DENSITY AND DISTRIBUTION

Beaver pond density was fairly low on the 226.63 square kilometers (87.5 square miles) of the Monument and Indian reservation- with 0.30 colonies/ km² (Table 1). Because there were few lakes most beaver dwellings were found on streams. Aerial photograph and ground checks revealed that the highest area of beaver activity was probably Snow Creek, as evidenced by the string of inactive ponds. The upper reaches of Poplar creek were fairly dense with old beaver habitations, but downstream, where it runs through the Monument, beaver density declined. Here there were no signs of old ponds, suggesting that the area was never heavily colonized by beavers. Throughout the rest of the reservation ponds were scattered and beaver lodge density was low.

Ground examinations of beaver lodges revealed that many were inactive (no beavers present). Of twenty colony sites checked on foot throughout the reservation and Monument, nine were inactive (45%) (Table 2).

Table 1. Lodge density and mean number of beavers per lodge in three National parks (G.PORTAGE=Grand Portage National Monument; VOYA=Voyageurs National Park; APOSTLES=Apostle Islands National Lakeshore; ISRO=Isle Royale National Park)
 *=Aerial survey 1986; # = see text; @ = trapping efforts 1978-1984.

#						
LDGS LDG						
LOCATION	KM2	SIZE	#LDGS	MEAN-#ADULT	MEAN-#YEAR.	MEAN-#KIT
G.PORTAGE	0.3	4.1	7	2	0.9	1.3
VOYA	0.9	5.7	50	3.1	1.5	3.1
APOSTLES	0.4	-	38	-	-	-
ISRO	0.4*	#	7@	-	-	-

Table 2. Beaver ponds examined on foot for activity and inactivity in Grand portage N.M. and G.P. Indian reservation.

<u>LOCATION</u>	<u>ACTIVE/INACTIVE</u>
POPPLE CREEK	ACTIVE
POPPLE CRK. TRIB.	ACTIVE
G.P. TRAIL	ACTIVE
LITTLE LAKE	ACTIVE
AHMIK POND	ACTIVE
AHMIK II	ACTIVE
MINERAL CENTER	INACTIVE
HOLLOW ROCK I	INACTIVE
HOLLOW ROCK II	INACTIVE
HOLLOW ROCK III	INACTIVE
HOLLOW ROCK IV	ACTIVE
OLD 61	INACTIVE
CENTER DRAINAGE	ACTIVE
SNOW CREEK I	INACTIVE
SNOW CREEK II	INACTIVE
SNOW CREEK III	INACTIVE
SNOW CREEK IV	ACTIVE
FORT CHARLOTTE	ACTIVE
PIGEON RIVER	INACTIVE
<u>CASCADES</u>	<u>ACTIVE</u>
TOTAL= 11 ACTIVE; 9 INACTIVE	

COLONY SIZE AND COMPOSITION

The four beaver lodges found and trapped in a complete count of Monument lands, and the three lodges trapped on the reservation, represent a wide variety of family groups, including a colonizing pair, a newly settled pair with young, and a family with yearlings and young (a discussion of these lodges follows). Average monument lodge size was 3.5 beavers (N=4) (Table 3), and average reservation lodge size was 4.7 (N=3) (Table 4). Combined average colony size was 4.1 beavers/lodge (N=7) (Table 5).

Several colonizing two year olds were captured, but no lodge was found where two year olds and breeding adults existed together.

Kit production was highly variable. Two lodges had no kits, one had one kit, and four had two (Tables 3 and 4). Average kit production was 1.3 kits/lodge.

Following is a summary and description of all lodges trapped during the study. Although habitat conditions are reported on in these lodge descriptions, a detailed quantitative analysis is presented in a later section.

Table 3. Lodge composition of beavers live trapped on Grand Portage National Monument. Sex is only for animals older than 1 year.

LODGE	BEAVERS CAUGHT	SEX	BEAVERS PRESENT	ADULTS	2 YEAR	YEARLINGS	KITS
POPLAR CR.	2	M;F	2	-	2	-	-
POPLAR TR.	3	M	4	2	-	-	2
G.P.TRAIL	2	2F	2	1	1	-	-
F.CHARLOT.	3	M;F	6	2	-	2	2
	10	3M;4F	14	5	3	2	4
MEAN LODGE SIZE-3.5							

Table 4. Lodge composition of beavers live trapped on Grand Portage Indian reservation. Sex is only for animals older than 1 year.

LODGE	BEAVERS CAUGHT	SEX	BEAVERS PRESENT	ADULTS	2 YEAR	YEARLINGS	KITS
LITTLE L.	2	M;F	3	2	-	-	1
SLASH	6	2M;2F	6	2	-	2	2
CASCADES	5	2M;F	6	2	-	2	2
	13	5M;4F	15	6	0	4	5
MEAN LODGE SIZE-4.7							

Table 5. Combined lodge totals for Grand Portage National Monument and Grand Portage Indian reservation.

LODGE	BEAVERS CAUGHT	SEX	BEAVERS PRESENT	ADULTS	2 YEAR	YEARLINGS	KITS
7 LODGES	23	8M;8F	29	11	3	6	9
AVERAGE LODGE SIZE-4.1				38%	10%	21%	31%

Monument lodges

Poplar Creek. The Poplar creek lodge is located on the Grand Portage trail approximately 1/2 mile southeast of old highway 61. Based on habitat analyses, Poplar creek is an old beaver site, as evidenced by beaver cutting 2 years old and 15-20 years old. Most desirable tree species have been cut back from the water and several old dams and pond boundaries are visible. Bernie Gestel (Grand Portage Chief Ranger- Resource Management Specialist) reports that in 1977 this pond was active with beavers in it. At some time the pond became inactive, but other beavers moved in during 1985. In 1986, however, the pond was inactive. Two beavers were caught during this study and fresh tree cutting was noted. A fresh dam was built and a newly flooded pond was present, but no lodge was constructed and the beavers were probably living in the one bank burrow discovered. The only tree species cut were balsam poplar (Populus balsamifera) and alder (Alnus rugosa), species not generally preferred by beavers. The two animals caught were male and female and their body measurements suggest that they were colonizing beavers, probably two years old.

These beavers may reproduce and persist at this site for a few years, but the site probably will not support a large colony for a long period of time as it has been occupied by beavers before and is now a poorer site.

Poplar Creek Tributary. Poplar creek tributary located 1/4 mile NW of the Poplar Creek lodge, slightly west of the trail, became a new pond in 1986. The habitat around the pond is still favorable for beavers. Many old aspen are down and fresh cutting of aspen is still occurring. This area was settled in 1986 and no previous activity is known. Water flow in this pond is low and the majority of the pond water is probably captured by the beavers from precipitation.

Two beavers probably colonized this site in 1986, for in 1987 one adult and two young animals were captured. Evening watches at this pond recorded no other animals.

Beavers at this site should remain until they utilize all the available aspen, and then may subsist for several years on less desirable tree species.

Grand Portage Trail (Boardwalk). This colony, located approximately 2 miles west from old highway 61 along the Grand Portage trail, has recently expanded its pond through new dam building, and in the process flooded a park boardwalk. This site, according to Bernie Gestel, has been active for at least ten years, and probably

longer as evidenced by cut trees 15-20 years old. There is aspen still available, but most of the aspen near the water has been cut. Some aspen were cut last year, but in 1987 beavers were cutting only balsam poplar.

At one time this pond had more open water, but is now mostly grown-over with aquatic vegetation, leaving only a small area of open water near the dam. Ground reconnaissance and aerial photo analyses revealed that this pond is an extended portion of the Snow creek drainage, an area of heavy past beaver use. With another drained pond upstream, and numerous ponds below on Snow creek, beavers probably travelled through here frequently over the years, with possibly several different beaver families settling.

Presently there are not many beavers, as only two were caught, and it is doubtful that there are young present. Both animals caught were females and not similar in size, one was a large adult and the other was probably a 2-year-old. Poaching occurred several years ago, and possibly the adult male was captured and another male has not replaced him, or possibly the male was taken by a predator. Regardless of the exact situation, there are not many beavers, as evidenced by their cutting and dam building activity.

It is unknown how long beavers will persist in this situation. Aquatic vegetation is a good beaver food, and beavers can survive many years on aquatics without abundant tree species.

Fort Charlotte. The Fort Charlotte beaver lodge is located on the Pigeon river, and is the largest colony on the Monument with at least 6 beavers. Not all beavers were caught, but an estimate of animals present would be a breeding pair, two yearlings, and two kits.

This lodge has likely been present for a number of years as evidenced by their cutting activity in an aspen stand. In 1966 an area behind their lodge burned, and since then young aspen has become reestablished, which the beavers are presently utilizing. Beavers are travelling 30-50 meters to reach this optimal sized aspen (4 inch dbh).

Conditions at this lodge are beginning to decline as evidenced by increasing distance travelled to obtain their desired food, but currently aspen is still available and beaver growth at this lodge is good. One animal was caught here that was assumed to be a yearling (based on physical measurements), but very heavy (16.7 kg) for this age class.

Beavers at this site will subsist for a few more years, as they will continue to utilize the aspen in the

burn, possibly moving their lodge site for better access. As aspen in the burn becomes exhausted, the beavers may leave the area in search of better forage, die, or be killed in search of adequate food.

Reservation lodges

Little Lake. Little Lake, being a roadside pond, could be easily trapped, but apparently little trapping has taken place here in recent years. Rick Novitsky (Resource Manager Grand Portage Band) reports that at one time several beavers were shot from this pond. Little Lake has probably had beavers in it for some time, for most of the hardwood species within 50 m of the pond have been cut. Some aspen was being cut, however, at a newly-reached site near the road and gravel pit at the east end of the pond. Other cutting sites are sporadically located around the pond, with less desirable species being cut.

Two adults, a male and a female, were captured and at least one kit was heard from the lodge on an evening watch.

Little Lake beavers may remain for a few years, subsisting on poorer tree species, but it would be unlikely that the colony will grow.

Ahmik Pond (Grand Portage Valley). Ahmik pond has become active only recently (approximately two years according to Rick Novitsky), but was occupied by beavers previously. Aspen cutting 10-15 years ago was found. Beaver food conditions around the pond are fairly poor, but last year they were travelling 80 meters to cut optimal size aspen in a recently logged area.

All beavers present were captured and handled- a breeding pair, two yearlings, and two kits.

Beavers probably will remain here for some time and continue utilizing the logged area. Eventually this aspen will be depleted and the beavers will be forced to feed on less desirable foods.

Cascades Lodge. The Cascades Lodge is another colony located along the Pigeon river. Five beavers were captured here and there are probably 6 present: a breeding pair, two yearlings, and two kits. Last year these beavers cut birch extensively close to their lodge, and now are traveling 200 meters in the water to obtain aspen. An inactive lodge is located upriver just below the Fort Charlotte rapids, so this beaver colony has been using this section of the river for some time.

Since these beavers are cutting in poorer areas farther from their lodge, their habitat conditions cannot

be considered good. This colony will probably continue to exist, however, as its location on the river allows this lodge a wider area in which to forage, decreasing overutilization of any one area.

PHYSICAL MEASUREMENTS

Beaver physical measurements were analyzed for three age classes: adults, yearlings, and kits. Average weights for those age classes were 18.9 kg (N=12), 13.8 kg (N=4), and 5.7 kg (N=7) (Table 6). The largest animal caught was a female along the Pigeon River weighing 23.4 kgs (52 lbs). The smallest animal was a kit, weighing 4.8 kgs (11 lbs), captured in a beaver pond near Ahmik Lake. Tables 6 & 7 summarize beaver weights and zygomatic arch measurements for Grand Portage, Voyageurs and Isle Royale beavers, and Appendix 1 lists individually all the beavers captured during the course of the study.

HABITAT ANALYSES

Cutting Activity and Vegetation Surveys

There was a high degree of variability in aspen

Table 6. Beaver weights (kgs) in three National parks. Sample size in parenthesis.

<u>LOCATION</u>	<u>ADULTS</u>	<u>YEARLINGS</u>	<u>KITS</u>
GRAND PORTAGE	18.9(12)	13.8(4)	5.7(7)
VOYAGEURS	19.6(113)	13.4(59)	6.5(131)
<u>ISLE ROYALE</u>	<u>17.75(6)</u>	<u>12.3(6)</u>	<u>5.9(13)</u>

Table 7. Beaver zygomatic arch measurements (mm) in three National parks. Sample size in parenthesis.

<u>LOCATION</u>	<u>ADULTS</u>	<u>YEARLINGS</u>	<u>KITS</u>
GRAND PORTAGE	101.8(12)	92.3(4)	72.1(7)
VOYAGEURS	100.1(111)	90.0(59)	73.4(130)
<u>ISLE ROYALE</u>	<u>97.0(6)</u>	<u>87.0(6)</u>	<u>72.6(13)</u>

density found around beaver lodges. Some lodges had no aspen available, while the Fort Charlotte colony had aspen densities of 1401 stems/hectare (Figure 1). Generally, aspen density at most lodges were fairly low. One other colony, found on the Poplar creek tributary, also had an ample supply of aspen (368 aspen stems/hectare), but signs of depletion were beginning to show.

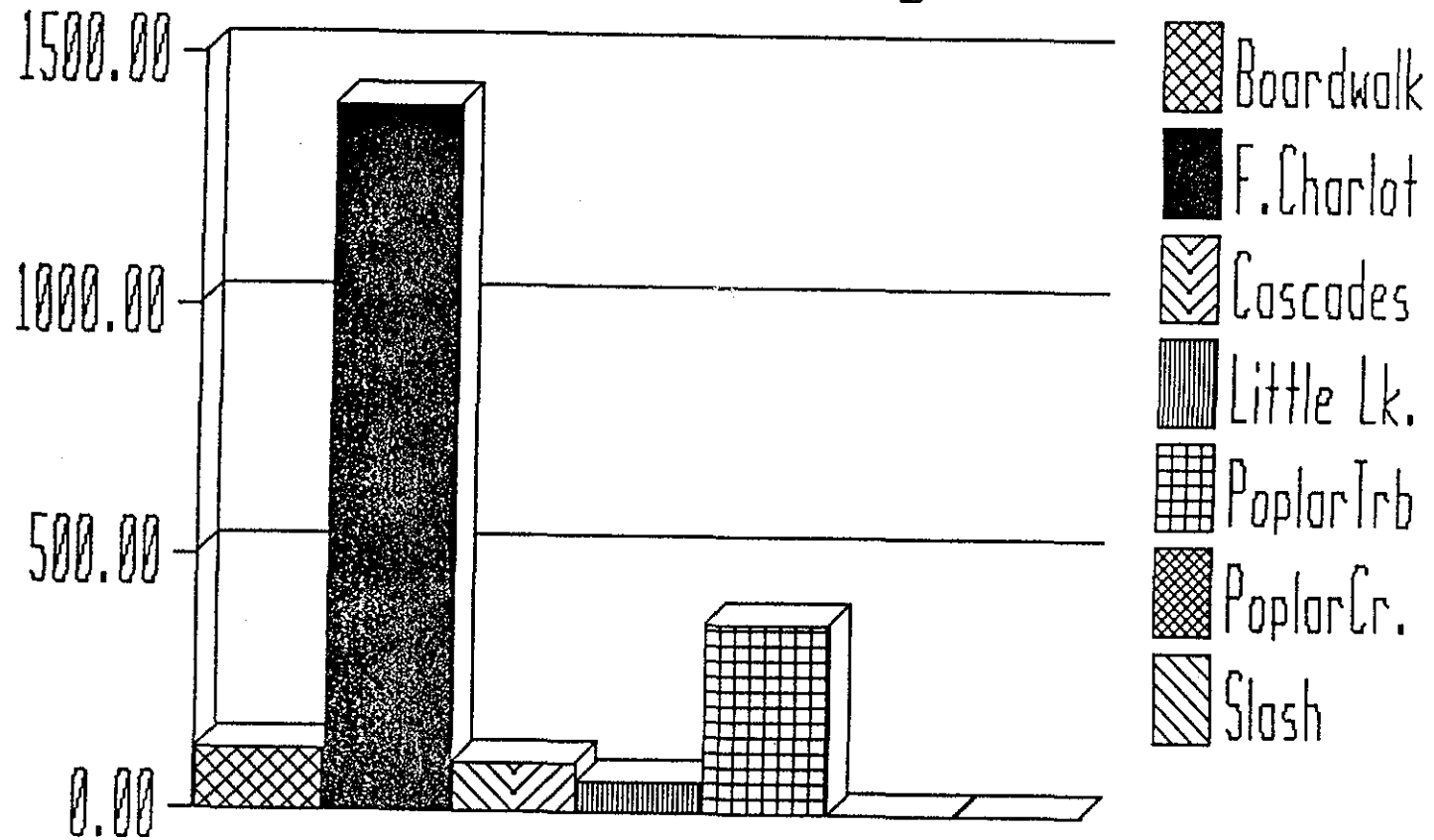
Beaver lodges sampled elsewhere did not have as much aspen. Data were gathered slightly prior to the beavers normal time of intensive food cutting for winter, but early cutting sites plus areas of heavy use last year were examined. Beavers at the other lodges either had no aspen available at all (Poplar Creek), or had aspen in very limited supply, sporadically distributed. At Little Lake and the Ahmik Pond beavers had a sparse aspen supply, 58 stems/hectare and 0 stems/hectare, respectively. The Ahmik beavers had some aspen that was not recorded on the vegetation lines because they were not presently using it, but they had in the past travelled 80 meters to this stand.

The Cascades beavers did have some aspen available, but were travelling long distances to harvest it, and thus were also making use of closer, less desirable foods. Finally, the Boardwalk beavers had cut much aspen last fall (1986), as they constructed a new canal gaining

Figure 1. Aspen density (stems/hectare) around beaver lodges
at Grand Portage National Monument and Indian
Reservation, Minnesota.

of stems/hectare

Aspen Density Grand Portage



Location

access to the new supply. New aspen areas, however, were fairly limited, only existing as single trees in fairly inaccessible locations. These beavers were presently cutting balsam poplar, and probably utilizing aquatics.

Water Characteristics

Water supplies at all of the lodges sampled were adequate for year round beaver habitation. The best flow year round was along the Pigeon River and Poplar Creek. The other ponds were all along ponds with variable flow, water levels depending to a large degree on the damming activities of the beavers.

Important to beavers is a lack of water fluctuation, and most of the ponds studied seem to be secure from major disruptions. The Pigeon River lodges may encounter flood conditions during the spring, but the beavers are probably able to adapt during this short period. More critical are periods of low flow, bringing water levels so low as to make lodge accessibility difficult. None of the Portage lodges seem to be in this situation, but Little Lake and the Ahmik Pond are probably most susceptible during extended periods of dryness.

WILDLIFE SIGHTINGS

Eight bird groups and four mammal species were monitored during the study (Table 8). The majority of these species monitored were aquatic dependent, but other "edge reliant species" were noted as well.

Four of the eight species of birds recorded were only seen in the vicinity of beaver ponds. These birds were all aquatic and included: 2 kingfishers (Ceryle alcyon), 4 great blue herons (Ardea herodias), 2 bitterns (Botaurus lentiginosus) and 10 ducks. Another aquatic bird sighted but not at a beaver pond, but a potential user was a pied-billed grebe (Podilymbus podiceps). Other birds seen and using the areas around beaver ponds were as follows: 3 woodpeckers, 2 hawks, and numerous migrating warblers and sparrows.

Three important aquatic furbearers, often dependent on beaver-created habitat, and one ungulate were also noted. One muskrat (Ondatra zibethicus) was sighted at a beaver pond. Eight otters (Lutra canadensis) were sighted, and of those eight, five were sighted at beaver ponds. In addition, otter sign was recorded frequently around beaver ponds. Mink (Mustela vison) and moose (Alces alces) were not sighted, but moose sign was seen frequently in the

Table 8. Wildlife sightings around beaver ponds. Numbers pertain to animals sighted at beaver ponds, and "only" refers to those only sighted at a beaver pond. Categories were formed on the basis of field work at Voyageurs National Park.

<u>BIRDS</u>		<u>MAMMALS</u>	
WOODPECKERS	3	OTTER	5
KINFISHER	2 (ONLY)	MUSKRAT	1 (ONLY)
G.B. HERON	4 (ONLY)	MINK	0
BITTERN	2 (ONLY)	MOOSE	TRACKS & SCAT
HAWKS	2		
DUCKS	10 (ONLY)		
GREBE	0		
OTHER	MIGRATING WARBLERS		
	& SPARROWS		

vicinity of beaver ponds. Other animal sign included one black bear (Ursus americanus) sighting, and several sightings of wolf (Canis lupus) tracks were recorded.

DISCUSSION AND CONCLUSIONS

Past and Present Beaver Population in Grand Portage

Beaver population trends in Grand Portage are consistent with beaver population changes elsewhere in northern Minnesota (Stenlund 1985, Smith and Peterson in press). Beavers at the turn of the century were scarce in Minnesota, due to the fur trade (Innis 1930), and the Great Cut (Swanholm 1978). Beavers, after being trapped out, had little opportunity for increase because of the massive destruction of their forested habitat. Ironically, the forest alterations eventually helped stage a large beaver increase through the Lake States region, beginning in the 1930s (Stenlund 1985). Cutting the large pines made conditions favorable for seral tree species like aspen and birch to colonize large tracts of land.

Aspen is the beaver's most preferred food, and beaver populations expanded greatly throughout the state of Minnesota. The first limited beaver trapping season was in 1939. Since then the season has become longer, and presently has no limit on the number of animals taken.

In the fifties Milt Stenlund (1953) reported on a massive beaver dieoff throughout the state of Minnesota,

and what was probably a dieoff throughout the entire Great Lakes region (Lawrence et. al. 1956), including Isle Royale (Shelton 1966; and pers. comm.). Prior to the outbreak beaver numbers had become high, and this epizootic evidently reduced their numbers. By this time, however, the beavers had already begun to impact the regenerated aspen. After the outbreak, beavers recovered, and continued harvesting aspen supplies adjacent to their drainages.

After the beaver recovery, aspen stands began to show signs of being depleted. Many factors were affected this rate of aspen utilization: topography, water characteristics, trapping pressure, wolf predation, and local disease outbreaks- to name a few. Generally though, aspen in most areas was beginning to show signs of depletion by the 1970s.

The Grand Portage area fits in well with this general Minnesota scenario. Much of the Indian reservation is aspen, and the beaver population has declined in recent years. Almost half (45%) of the 20 beaver ponds examined were inactive and usually depleted of aspen. The beaver population also is showing signs of stabilization and reduced productivity. Colony size is low, and number of young produced per lodge is also lower than beavers living under good conditions. Lodge

composition also suggest low density. Novakowski (1965) and Nordstrom (1972) suggests that the prescence of two-year-olds and adults in the same lodge indicate a saturated or dense beaver population. Two-year-olds will delay dispersal because of few available sites to settle, and larger size in subsequent years will give them a competetive edge when vying for limited sites. No situation similar to this was documented during this study, indicating again a generally low beaver density in the area. Additionally, most active and inactive ponds show signs of past aspen utilization.

Locally beavers will continue to take advantage of new opportunities for pond growth (enabling access to new aspen reserves), or settling new areas that may become available for beaver habitation. Fort Charlotte beavers, for example, have found new aspen, and beavers in Poplar Creek tributary recently established a new pond.

Beavers are able to adapt to a variety of conditions. Flexibility in food habits is one such example. Jenkins and Busher (1979), in their review of beavers call them a "choosy generalist". They "choose" aspen when given a choice, but can subsist on other foods as well. Aquatic vegetation and many deciduous tree and shrub species are also foods which beavers can subsist on for years, perhaps in some cases on a sustained yield basis (Boyce 1974), or

on a "rest-rotation" type arrangement (with the same colony not necessarily involved in the rotation between several ponds). Predicting future beaver population trends then, is possible only in a generalized way.

In short, Grand Portage beavers have recently declined and stabilized. Their population is still healthy, but shows signs of lessened productivity. In the future, individual beavers will no doubt opportunistically settle widely-scattered new areas, but a population increase is not expected- unless fire or logging regenerates aspen and other seral species that are conducive to beaver population growth.

Grand Portage Compared to other Lake State Parks

Aerial surveys have been recently conducted for Voyageurs and Isle Royale National Parks, and Apostle Islands National Lakeshore. Extensive live-trapping and habitat data are available from Voyageurs, and some data are available from Isle Royale, but no data have yet been collected on the ground in Apostle Islands. This collection of preliminary information does allow some basic conclusions to be made about beavers in the four areas.

Statistically, aspen density at Grand Portage lodges is similar to all of the Voyageurs areas sampled but one. West Rainy lake in Voyageurs has the densest aspen of any area sampled (1106 stems/hectare), but the other areas in Voyageurs are comparable to Grand Portage aspen densities (mean density = 450 stems/hectare) (Figure 2). Mean number of aspen stems/hectare at both areas is highly variable by lodge, so these mean values are of only limited utility.

Although systematic sampling is just getting underway at Isle Royale, past research and present analyses indicate that beaver habitat there is perhaps in the worst condition (low aspen density and accessibility) of any of the three areas investigated (Apostles habitat data have not yet been gathered). Many lodges at Isle Royale are subsisting in the absence of any aspen supply (Shelton pers. comm).

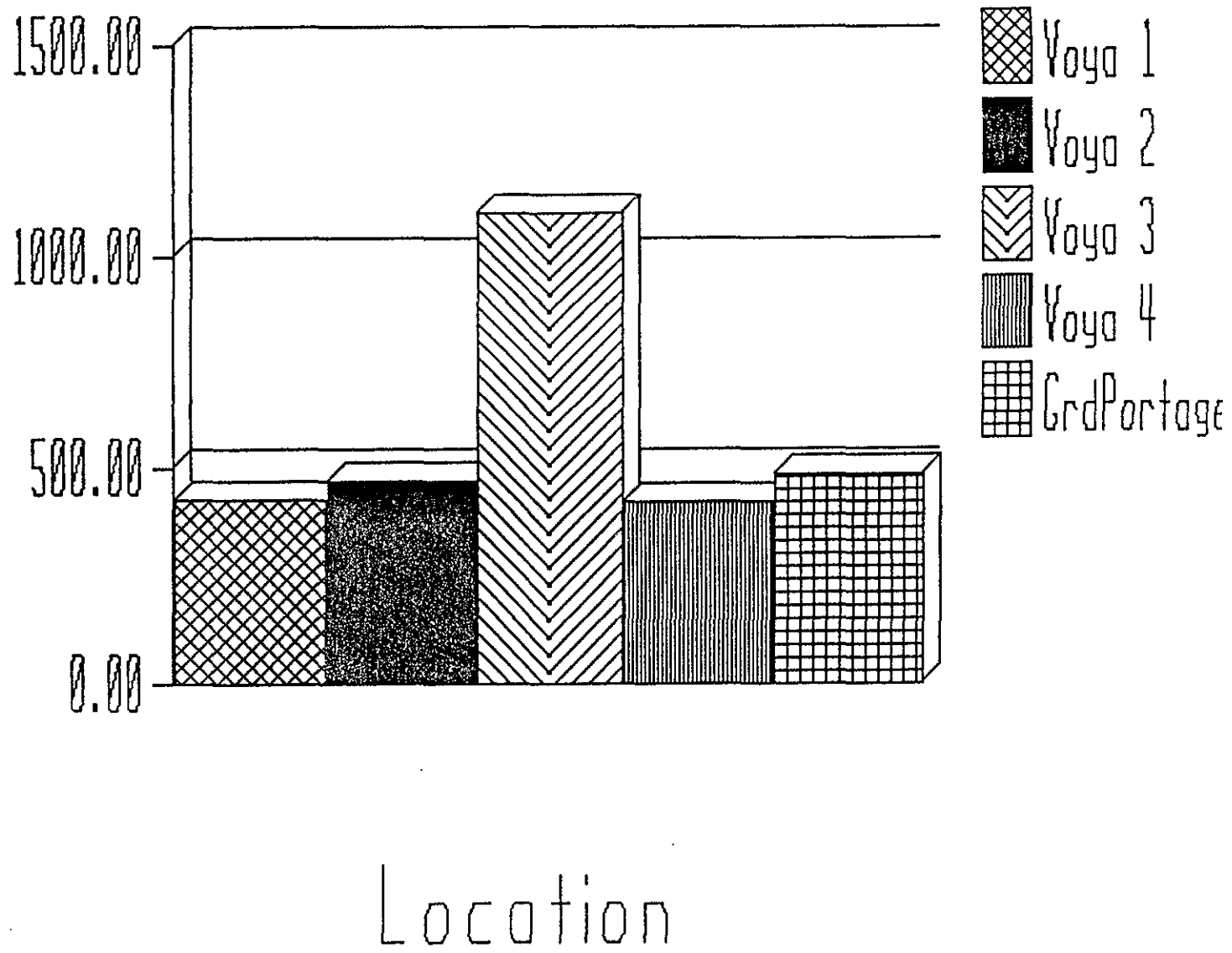
Isle Royale and Apostles are similar to Grand Portage in that most of the beaver habitations are ponds constructed from dammed streams. Apostles is exclusively beaver ponds of this type, while at Isle Royale several (but not the majority) of the beaver habitations are on inland lakes or along the Lake Superior shoreline. Voyageurs presents a much more variable setting, with many creek and inland lake dwellings, but also a great number of lodges on the large lakes.

Figure 2. Habitat comparison (stems aspen/hectare) between
Voyageurs National Park and Grand Portage National
Monument, Minnesota.

of Stems/hectare

Habitat Comparison

Voyageurs-Grand Portage



Number of beavers per lodge at Grand Portage (4.1) are smaller than Voyageurs (5.7) or Isle Royale (6.3; from Shelton 1966) No data at this time is available from Apostles. Kit production is also less at Grand Portage than any of the other areas sampled.

Beaver physical measurements at Grand Portage are comparable to Voyageurs. Adult beavers in Voyageurs, however, are slightly larger, probably because of access to more aspen. Kits at Grand Portage are the smallest of the three areas. Isle Royale adult beavers appear to be showing the effects of a poorer habitat, as they are the smallest. Low sample sizes do not allow statistical comparisons.

On Isle Royale Krefting (1963) has documented beaver utilization and exploitation of aspen in the 1950s, so the cycling of beavers on Isle Royale is further along than in the Minnesota study sites. The smaller beaver size reflects these habitat characteristics. With intense wolf predation (Shelton and Peterson 1983) (a much higher wolf density in many years than adjacent Minnesota, and a heavier reliance of wolves on beaver), combined with depleted habitat (Shelton 1987), beavers on Isle Royale are well past their peak period.

Grand Portage has a low beaver density, similar to Isle Royale, but is slightly behind in terms of habitat

depletion or beaver population cycling. The aerial photo interpretation method of counting beaver ponds is less accurate than an actual aerial census. Thus, beaver density at Grand Portage is comparable with Isle Royale, but some areas of limited aspen availability make conditions at Grand Portage slightly better for beavers.

Beaver density in the Apostle Islands is approximately equal to Isle Royale, but the beaver population exists on two islands, each discreet from each other. Thus, the density reported here represents two islands combined: one island having a high density (0.7 lodges/ km²) and the other having a fairly low density (0.3 lodges/ km²). From the air it could be seen that beavers were cutting aspen in some places, but generally aspen has been well utilized. There are also a large number of inactive ponds, and some beaver meadows, suggesting beaver population declines.

The Voyageurs beaver population is much denser, and more productive than any other of the areas sampled. Average lodge size, kit production, and beaver physical measurements indicate generally favorable conditions for beavers in this area. It should be noted though, that there is a high degree of beaver population variability in Voyageurs. In some areas where the beavers are still dense, the habitat is very poor. In other areas,

conditions are excellent, and beaver population growth is expected.

Beavers in Grand Portage are generally in a similar population phase as beavers elsewhere in the Lake State National Parks. Voyageurs is most different from Grand Portage in terms of aspen supply and beaver density, but similar trends, under slightly different circumstances, are taking place in Voyageurs.

Beaver Habitat Alterations and its Affects on other Wildlife at Grand Portage

The landscape alterations of beavers are well known, and have been widely observed and described (Morgan 1868; Sandoz 1964; Lavender 1977; Wallace ?; Wallace and Lathbury ?). These alterations to the forest or stream environments almost always change or disturb the previous setting. This disturbance is key to the survival and existence of many other forest wildlife species. The only other natural processes that disturb more land than do beavers are fire and insect infestations.

Many birds and mammals adapted to disturbance not only depend on aquatic habitats in beaver ponds for food and cover, but also on the shrubby growth around beaver ponds. (Kirby 1975). Many passerine bird species use these

areas as nesting sites. Aquatic mammals like the mink, muskrat, and otter regularly use beaver ponds for feeding and homesites (Hazard 1982; Route and Peterson in press). Reptiles, amphibians, and fish frequently utilize small bodies of water for breeding, and for year round dwelling sites (Cook 1940; Scott and Crossman 1973; Kirby 1975). Finally, large ungulates and predators also benefit from the prescence of beavers and beaver ponds (Mech 1970, Voight et. al. 1976; Shelton and Peterson 1983).

Several in-depth studies have been conducted on the environmental significance of beaver-created ponds and swamps. Perhaps of the greatest interest is the beaver's effect on aquatic furbearers- mink, muskrat, and otter. All three of these mammals are present at Grand Portage, and require aquatic habitats, which beavers create on a widespread basis. Additionally, each of these mammals will utilize beaver lodges as den sites. Sometimes local fish populations concentrate below beaver food caches, which in turn provide food for otters and mink. Route and Peterson (in press), and Leighton (1930) provide more detailed accounts of beaver-aquatic furbearer relations.

Recently fish in beaver ponds, especially trout, have become important topics of study. Beavers do much to create habitat for many fish species- some are desirable game fishes like brook trout (Salvelinus fontinalis) (Cook

1940). Still others claim that slowing of streams by beavers leads to warmer water and increased sedimentation of streams, a situation not favorable to cold water fish.

Beavers create a tremendous amount of habitat for both water and land birds (Terres 1982). Benefits to waterfowl, both in terms of feeding and nesting sites, has been extensively described (Bellrose 1976). Wading birds also benefit greatly (Hancock and Kushlan 1984). Some warblers (Chapman 1917; Bent 1955; Harrison 1984) and sparrows (Terres 1982) find the forest changes created by beaver disturbance favorable for settling. Dead snags, caused by beaver flooding and by opening the forest canopy (killing shade tolerant species), provide an abundance of feeding and nesting sites for several woodpeckers (Bent 1939).

Large ungulates such as deer and moose benefit greatly from beaver ponds. Moose feed on aquatic plants found in beaver ponds at certain times of the year, and use the water as escape cover from summer heat and insects (Peterson 1977). White-tailed deer make use of the shrubby edge around beaver ponds as feeding sites (Hesselton and Hesselton 1982).

Lastly, many predators also feed on beavers. Beavers are a major summer food item for wolves (Mech

1970; Peterson 1977; Voight et. al. 1976), and have been reportedly killed infrequently by coyotes and foxes (Packard 1940; Payne and Finley 1975). For wolves, beavers may play a role in wolf population fluctuations, perhaps through summer pup survival (Mech 1970; Peterson 1977).

While studying beavers at Grand Portage, many of the interactions described above were encountered. Birds of many different species were observed, and some species were only sighted around beaver ponds (Heron and kingfisher). Several otters were seen in beaver ponds, and moose sign was common.

The Poplar Creek and Poplar Creek tributary beaver ponds are excellent examples of a break in forest structure, changing the landscape to benefit many animal species. If it were not for the beaver ponds, the area would be continuous forest, lacking considerably in animal diversity.

The Snow Creek drainage has been extensively altered by beavers, and continues to be affected by them. Otters, and many migrating sparrows, warblers, and ducks were seen in this area. These aquatic habitats will provide food for moose, and brushy edge nesting sites for passerine birds.

The beavers at the Fort Charlotte site are logging aspen so extensively that it is speeding forest succession by allowing for early spruce development. Some shrubby species like willow are benefiting from the aspen removal, but eventually they too will be shaded out by the spruce. Soon afterward these forest alterations will lead to changes in the bird and mammal species utilizing the area.

In conclusion, the beaver's value in the Grand Portage setting is very high. From an interpretational and biological standpoint, the diversity of animal and plant associations that are promoted by beaver activity is tremendous. Historically, beavers are a key element in the story of human exploration of a continent, exploitation of an animal, and its subsequent recovery. Thus, the presence of beavers in Grand Portage adds significantly to past and present biological and cultural values.

Beaver Movements in Relation to Monument Size

The beaver population of Grand Portage National Monument will reflect beaver population changes on the adjacent Indian reservation. Beavers are capable of moving long distances (Smith and Peterson, Voyageurs N.P. final report; Leege 1968), and the several stream courses

that cross the trail will link together the Monument and reservation, providing travel ways for dispersing beavers. Likewise, because suitable sites for beavers are of a limited nature on Grand Portage land, few resident dispersers will settle on the Monument. Presently, with much deteriorated habitat, beavers will most likely have to travel longer distances for a suitable habitation site, subjecting them to a greater mortality risk than non-dispersing beavers.

MANAGEMENT RECOMMENDATIONS

Boardwalks and Trails

The main purpose of Grand Portage is its historic fur trading trail, so any beaver alterations of the terrain may present problems. Several sites exist where conflicts between beavers and trail right of way can occur. Beavers are presently a problem at the Boardwalk Lodge (see Results), and two others, Poplar Creek and Poplar Creek tributary, could possibly become conflict areas.

When conflict situations arise we discourage beaver removal or modification of their structures. Instead, constructing bridging or boardwalks over their flooding and construction activities would be the most suitable management alternative. This management approach would be consistent with National Park policy as it pertains to wildlife (Mgmt. Policies of NPS-1978), maintain the actual Portage route, and eliminate the need to re-route this historic trail. Bridging of this nature has been very successful in other National Parks (Isle Royale and Voyageurs).

Beaver removal is also not recommended for two other reasons. Removal of "nuisance" beaver would require

constant vigilance, as abandoned sites would be quickly reoccupied. Also, beaver removal represents a loss of natural values that are especially pertinent to the fur trade.

Trapping Considerations and Beaver Protection

Continued enforcement of no trapping and patrol for beaver poachers is encouraged. Monument managers should also be keenly aware of market prices for beaver pelts. This will likely be the best indicator of when to be on the lookout for poaching activity. Presently, beaver pelt value is fairly low, and not much interest in beaver trapping was found upon talking to individuals on the reservation. These feelings, however, are quick to change when money makes risk-taking more worthwhile.

Based on our findings, we do not presently recommend the establishment of a buffer zone around the trail to protect beavers from trapping. The ponds of concern that would receive protection outside the Monument already are somewhat isolated. Currently, lodges trapped on reservation land do not appear to be showing the affects of harvesting, so a buffer for Grand Portage beavers would presently be of little benefit. As fur prices change, however, trapping pressure can be expected to increase.

APPENDIX 1

GRAND PORTAGE BEAVER CAPTURES

No.	Tag	Date	Location	Weight (kg)	Total Length (mm)	Hind Foot (mm)	Zyg Brth (mm)	Tail Length (mm)	Tail Width (mm)	Sex
1	B280	26-Aug-87	Pop.Trib	6.0	735	144	78	195	78	?
2	B256	26-Aug-87	Boardwlk	16.75	1052	180	100	292	120	F
3	B259	27-Aug-87	Pop.Trib	19.25	1092	187	101	282	140	M
4	B283	27-Aug-87	LittleLk	18.6	1085	187	102	187	140	M
5	B260	27-Aug-87	Boardwlk	23.0	1152	191	107	282	136	F
6	B204	28-Aug-87	Ahmik	5.0	670	134	68	170	75	?
7	B212	28-Aug-87	Ahmik	13.5	983	175	89	253	112	F
8	B251	28-Aug-87	PoplarCr	13.5	955	167	97	255	120	F
9	B263	28-Aug-87	LittleLk	16.75	1024	193	103	294	125	F
10	B262	30-Aug-87	Pop.Trib	5.6	739	140	71	204	77	?
11	B289	31-Aug-87	Ahmik	13.4	950	177	90	240	115	M
12	B206	03-Sep-87	Ahmik	4.8	675	132	71	175	75	?
13	B291	03-Sep-87	PoplarCr	15.6	980	182	98	260	117	M
14	B288	04-Sep-87	Ahmik	19.7	?	185	106	282	120	F
15	B205	05-Sep-87	Ahmik	17.0	?	173	100	253	140	M
16	B281	07-Sep-87	F.Charl	16.7	1022	191	93	257	127	F
17	B227	09-Sep-87	Cascades	6.5	809	140	73	209	83	?

18	B253	09-Sep-87	Cascades	14.75	1040	180	93	290	130	M
19	B252	10-Sep-87	Cascades	19.25	1122	180	103	272	150	M
20	B287	10-Sep-87	F.Charl	6.0	735	138	75	185	70	?
21	B290	11-Sep-87	Cascades	23.4	?	187	103	187	158	F
22	B261	11-Sep-87	Cascades	6.2	900	139	69	250	80	?
23	B278	11-Sep-87	F.Charl	21.0	?	185	105	282	128	M

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